UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/779,966	02/17/2004	Michael J. Berman	03-1804	9510

24319 7590 04/27/2005

LSI LOGIC CORPORATION
1621 BARBER LANE
MS: D-106
MILPITAS, CA 95035

EXAMINER	
NGUYEN, GEORGE BINH MINH	
ART UNIT	**PAPER NUMBER**
3723	

DATE MAILED: 04/27/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

SP

Office Action Summary	Application No.	Applicant(s)	
	10/779,966	BERMAN ET AL.	
	Examiner	Art Unit	
	George Nguyen	3723	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 February 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-22* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-22* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Receipt is acknowledged of Applicant's election of Species I, figures 2-3, claims 1-22.

Claims 1-22 are presented for examination.

This application has been filed with formal drawings which are not acceptable to the examiner as indicated below.

Drawings

1. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the limitations of "countering the noise by broadcasting an audio signal" must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New

Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 1-22 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Due to the above drawing objection, it is unclear to one skilled in the art at the time the invention was made on how to make and the invention regarding to generating an audio signal to reduce the harmonic oscillation. Furthermore, the specification merely discloses generating an audio signal to reduce the harmonic oscillation. There are no further details on how to make or use the audio signal to reduce the harmonic oscillation.

Allowable Subject Matter

4. Claims 1-22 would be allowable if rewritten or amended to overcome the rejection(s) under 35 U.S.C. 112, 1st paragraph, set forth in this Office action.

The following is an examiner's statement of reasons for allowance: the specific limitations of "countering the noise associated with ... by changing one or more characteristics of the process" in claim 1, "changing at least one characteristic of the chemical mechanical process to reduce the harmonic oscillation" in the combination as claimed in claim 2, "performing experiments to determine how characteristics of the chemical mechanical polishing process should be changed to reduce harmonic oscillation" in the combination as claimed in claim 13, and "a reactor configured to receive information from the detector and react ... changing at least one characteristic of the chemical mechanical polishing process to reduce the harmonic oscillation" in the combination as claimed in claim 14 are not anticipated nor made obvious by the prior art of record in the examiner's opinion. For example, with reference to Figures 1-2, Sampson discloses an apparatus and method for monitoring CMP process. Acoustic emission samples for CMP polishing process are acquired and analyzed using a Fourier transform to detect wafer vibrations characteristic of scratching. When excess noises levels are detected at frequencies or within frequency bands being monitored, the polishing process is halted. In col. 2, lines 49-59, Sampson discloses that each transducer 126 is connected to analyzer and controller 128, which analyzes the measured acoustic waveform and controls the drive mechanism coupled to wafer chuck 114 and polishing platen 104 and driving mechanical aspect of the polishing process. In col. 3, lines 1-9, Sampson discloses that since the polishing process is at least partially mechanical, abnormal conditions such as the presence of a scratch-causing particle between the wafer 116 and the polishing pad 106/platen 104 may be detected by

abnormal vibrations (acoustic) resulting from scratching. In col. 3, lines 25-29, Sampson further discloses that the presence of a scratch-causing effects will result in the appearance of many ***harmonics***, which renders monitoring of a single frequency (such as for endpoint control purposes) unreliable for scratch detection purposes. From these above disclosures, the examiner infers that Sampson implicitly discloses that scratching-causing effects were caused by harmonic oscillation or abnormal vibrations. However, Sampson does not disclose the step of changing one of the characteristics of the CMP process to reduce the harmonic oscillation.

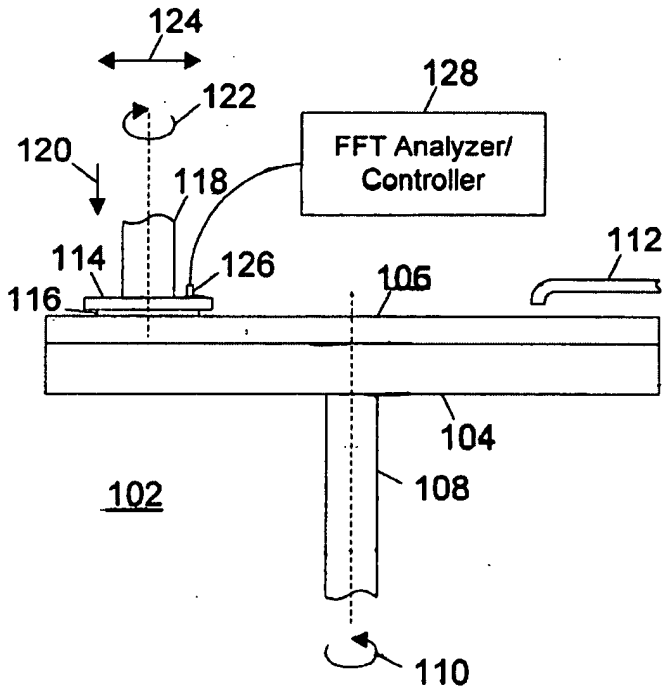


Figure 1

image of the acoustic noise generated by the polishing process. The spectral content of the detected acoustic signal is then analyzed. Since the polishing process is at least partially mechanical, abnormal conditions such as the presence of a scratch-causing particle between the wafer **116** and the polishing pad **106**/platen **104** may be detected by abnormal vibrations (acoustics) resulting from the scratching process.

Examination of the physical scratch defect appearing on a wafer surface as a result of a particle or other impurity becoming embedded within the polishing pad reveals localized damage in the form of a periodic series of indentations. The periodic nature of this damage indicates a vibration during contact of the impurity with the wafer surface. By detecting this vibration, the polishing process may be halted prior to serious damage to the wafer.

Numerous polish endpoint detection mechanisms employing acoustic sensors, generally measuring the level, frequency, or reflection time for acoustic emissions of the polishing process, have been proposed or employed. Such endpoint detection—that is, a shift in the frequency peaks when the polish material changes from oxide to a nitride etch stop layer or from metal or oxide—may be integrated with the analysis and monitoring system of the present invention. However, the presence of a scratch-causing defect will result in the appearance or many harmonics, which renders monitoring of a single frequency (such as for endpoint control purposes) unreliable for scratch detection purposes.

Generally the presence of particles or other impurities embedded into the surface of polishing pad **106**, or physically located between polishing pad **106** and wafer **116**, will alter the vibration or spectral emissions emanating from the polishing process. Performance of a fast Fourier transform on such emissions allows specific frequencies or frequency bands to be monitored for changes. An output of the Fourier transform in excess of a threshold at specific frequencies or frequency bands will indicate scratching of the wafer.

A reference spectrum established by comparing the emissions of the polishing process without scratch-causing particles and with scratch-causing particles intentionally introduced enables determination of appropriate sampling intervals and the frequencies or frequency bands to monitor to facilitate early detection of anomalies. The characteristic spectral response from defects should be sufficiently noisy to negate the need for a baseline analysis at the beginning of each polishing process.

Referring to FIG. **2**, a high level flow chart for a process of detecting wafer damage during polishing in accordance with a preferred embodiment of the present invention is illustrated. The process begins at step **202**, which depicts chemical-mechanical polishing of a wafer being initiated, such as by loading a wafer from a cassette onto the wafer chuck and lowering the wafer into contact with the polishing pad while one or both of the wafer and the polishing pad are rotated.

The process first passes to step **204**, which illustrates sampling acoustic emissions from the polishing process over a selected time interval. The optimal time interval should be selected after analyzing spectral emissions of a polishing process into which scratch-causing particles have been intentionally introduced, but generally should not exceed a few seconds. The process next passes to step **206**, which depicts performing a Fourier transform—preferably a fast Fourier transform—on the sampled acoustic emissions to determine noise levels at one or more preselected frequencies or within one or more preselected frequency bands.

Again, the frequencies or frequency bands which should be monitored may be determined from analysis of a polishing process during which scratching occurs. The noise levels at the selected frequencies or within the selected bands are examined for an indication of scratching during the polishing process.

The process passes next to step **208**, which illustrates a determination of whether scratching of the wafer is indicated from the analysis of the sample acoustic emissions. If so, the process proceeds to step **210**, which illustrates halting the polishing process and signaling an operator, who may then remove the scratched wafer from the chemical-mechanical polisher and clean or replace the polishing pad, as warranted. If no scratching of the wafer being polished is indicated by the sampled acoustic emissions, however, the process proceeds instead to step **212**, which indicates a determination of whether the polish endpoint has been reached. Numerous conventional polish endpoint detection schemes may be employed, although frequency-shift based detection may be more readily integrated with the FFT analysis of the present invention.

If the polish endpoint has not yet been reached, the process returns to step **204** to acquire another sample of the acoustic emissions from the polishing process. Those skilled in the art will recognize that, in practice, step **204** is likely to be performed concurrently with steps **206**, **208**, and **212**. That is, a sample of the polishing process' acoustic emissions will be acquired at the same time that one or more previous samples is processed and analyzed for an indication of scratching and/or endpoint detection. Once the polish endpoint has been detected, the process proceeds from step **212** to step **214**, which depicts the process becoming idle until polishing of another wafer is initiated (e.g., the next wafer from the cassette is retrieved and mounted for polishing).

The present invention employs detection of lower order harmonics relating to wafer vibration for in-situ detection of scratching during chemical mechanical polishing. Noise acquired by an acoustic transducer proximate to the polishing process is analyzed using a Fourier transform to identify alarming noise levels within the appropriate harmonics. The process may be stopped before serious damage to the wafer being polished occurs. In any event, damage is limited to a single wafer even with batch processing. Since vibration may be localized and somewhat damped over distance, multiple acoustic transducers may be employed for large wafers (e.g., ten inches or larger).

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A chemical mechanical polisher, comprising:

a polishing platen on which a polishing pad is selectively mounted;

a wafer chuck on which a wafer to be polished is mounted, the wafer chuck capable of being selectively lowered until the wafer contacts the polishing pad;

an acoustic transducer positioned proximate to a contact region between the wafer and the polishing pad;

an analyzer performing a Fourier transform on samples acquired by the acoustic transducer and examining the output of the Fourier transform for noise indicating scratching of the wafer; and

a controller halting polishing of the wafer upon detection of noise indicating scratching of the wafer.

With reference to Figure 6, col. 3, lines 1-12, Meikle et al.'5,439,551 discloses CMP process, upon detecting a change in the sound waves as the CMP polishing action

continuing, changing a chemical-mechanical polishing process operational parameter upon the detection of the change and then continuing chemical-mechanical polishing with the changed operational parameter.

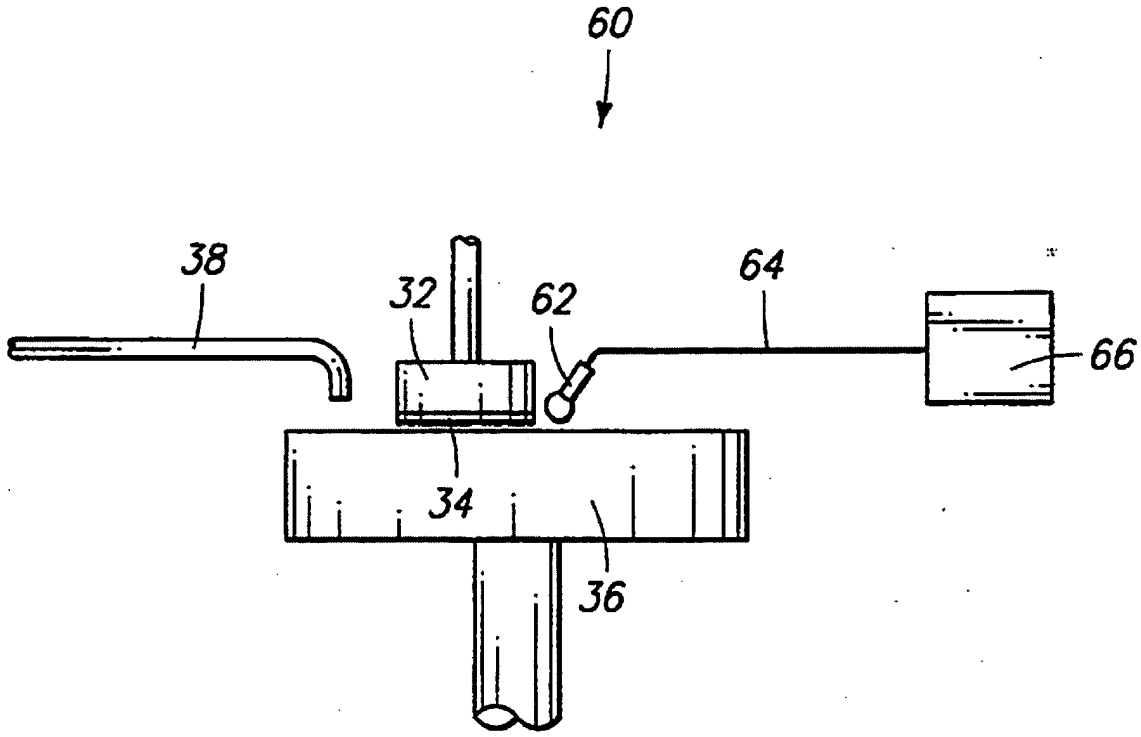


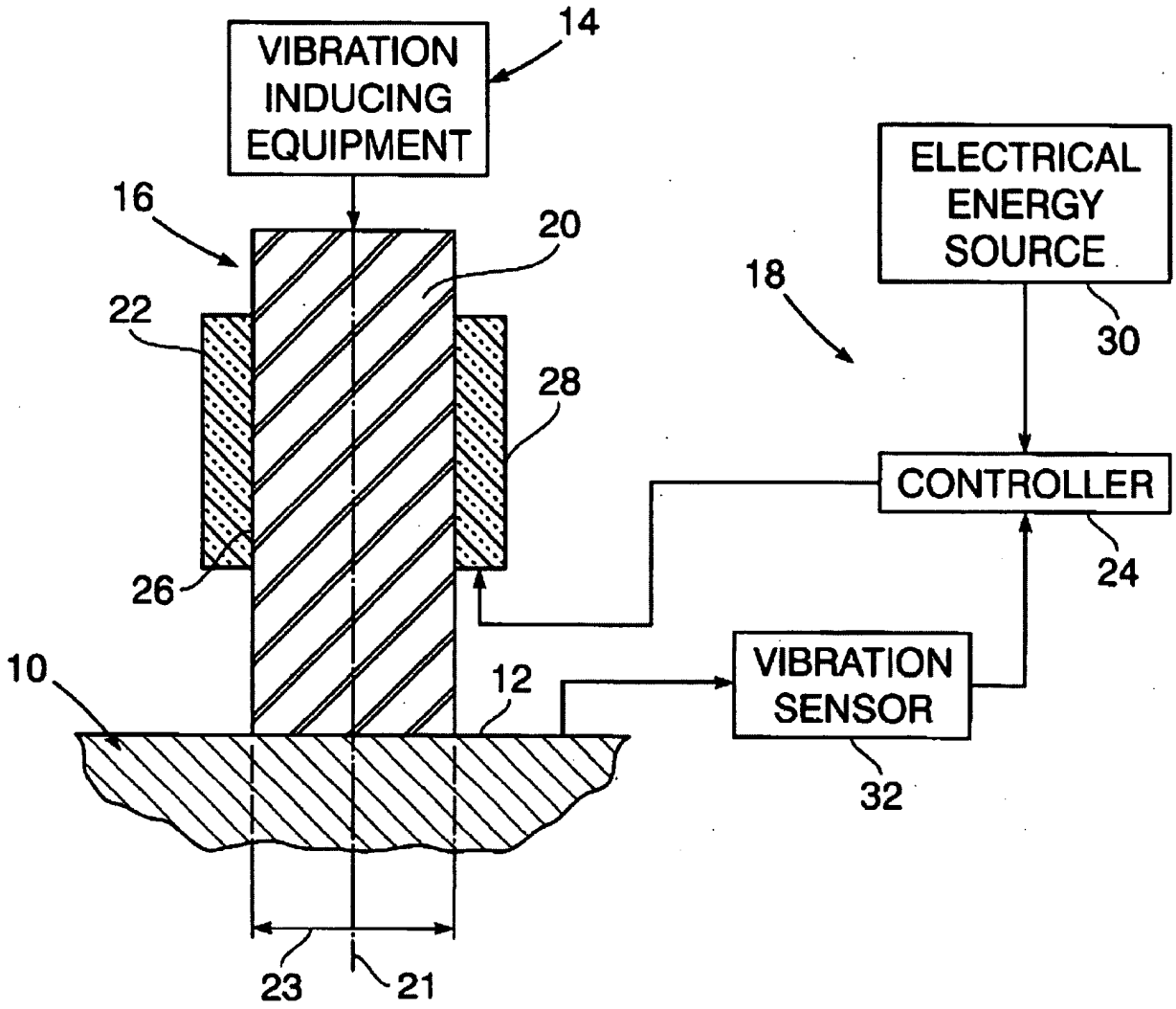
Fig 6

changing a chemical-mechanical polishing process operational parameter upon detection of the change and then continuing chemical-mechanical polishing with the changed operational parameter.

Example chemical-mechanical polishing process parameters include pressure of the wafer against the pad, slurry composition, slurry temperature, slurry flow rate, rotational speed of both the pad and the wafer, etc. In the course of detecting a change in the sound waves emanating from the process, multiple of these chemical-mechanical polishing process operational parameters might be desirably changed.

With reference to Figure 1, Jones discloses a piezoelectrically controlled vibration reducing mount system. Equipment having a source of vibration associated therewith is mechanically supported with strict positional tolerance on the floor surface by an elastic cylinder made of rubber. Such elastic cylinder is stiffened by a bulge restricting sleeve made of piezoelectric ceramic material so that fluctuating voltage applied thereto from a source of electrical energy under active control, during the continuous sensing vibrations transferred to the surface, null the bulge restriction of the stiffening sleeve to reduce the vibrations transferred to the surface within the operational frequency range of the vibration source associated with the equipment.

FIG. 1



With reference to Figure 2, Pan et al.'5,852,667 discloses a digital feed-forward active noise control system. In Figure 2, a sound attenuating earcup 11 is fitted over the ear 13 of a user, and seals to the skin of the user. A reference microphone 15 is located just outside of the earcup, e.g. on an axis with ear canal 17 of the user. An electroacoustic transducer (earphone 19) is located within the volume between the earcup 11 and the

ear 13, also preferably on the axis with the ear canal and microphones 15. An error microphone 21 is also located in the volume between the earcup 11 and the ear 13, also preferably on the aforenoted axis.

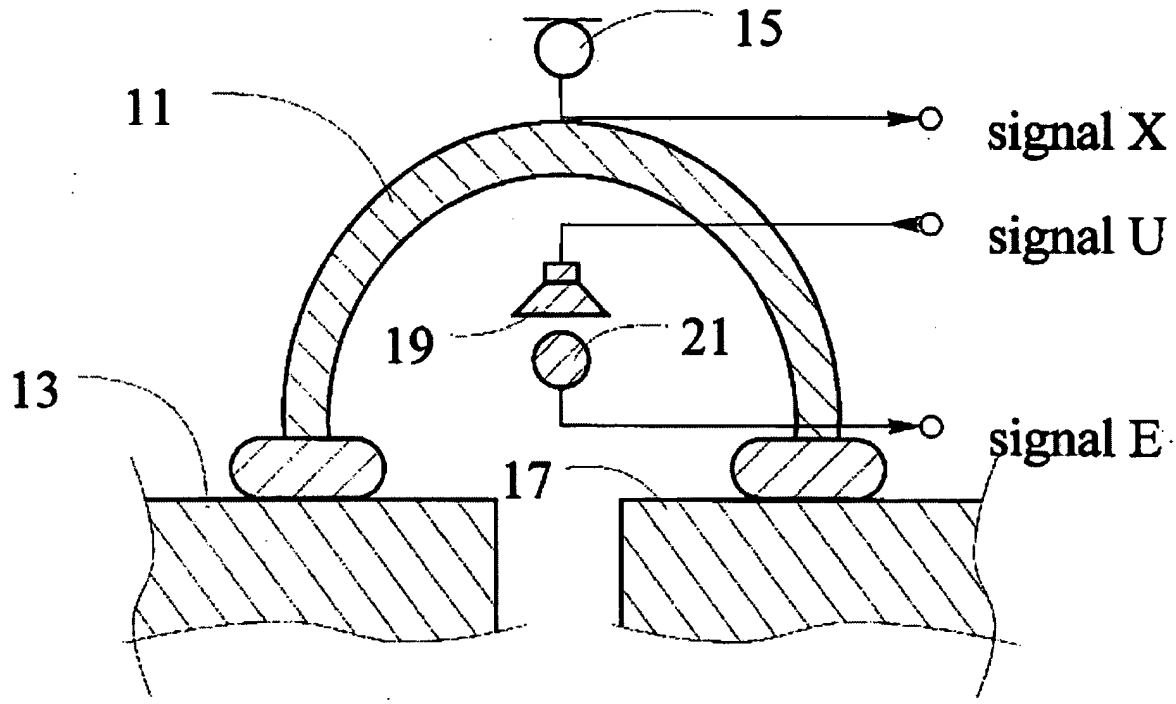


Fig. 2

However, the prior art of record fails to provide or suggest the specific limitations of "countering the noise associated with ... by changing one or more characteristics of the process" in claim 1, "changing at least one characteristic of the chemical mechanical process to reduce the harmonic oscillation" in the combination as claimed in claim 2, "performing experiments to determine how characteristics of the chemical mechanical polishing process should be changed to reduce harmonic oscillation" in the combination

as claimed in claim 13, and "a reactor configured to receive information from the detector and react ... changing at least one characteristic of the chemical mechanical polishing process to reduce the harmonic oscillation" in the combination as claimed in claim 14.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

5. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Yu'5,222,329 discloses acoustical method and system for CMP process. Matsuoka'4,419,897 discloses apparatus for harmonic oscillation analysis. Pla'5,789,678 discloses method for reducing noise and vibration from multiple rotating machines. Malkin et al.'6,210,259 discloses method and apparatus for lapping of workpieces with harmonic oscillation.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to George Nguyen whose telephone number is 571-272-4491. The examiner can normally be reached on Monday-Friday/630AM-300PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Joseph Hail can be reached on 571-272-4485. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

George Nguyen
Primary Examiner

George Nguyen
Primary Examiner
Art Unit 3723

GN – April 18, 2005